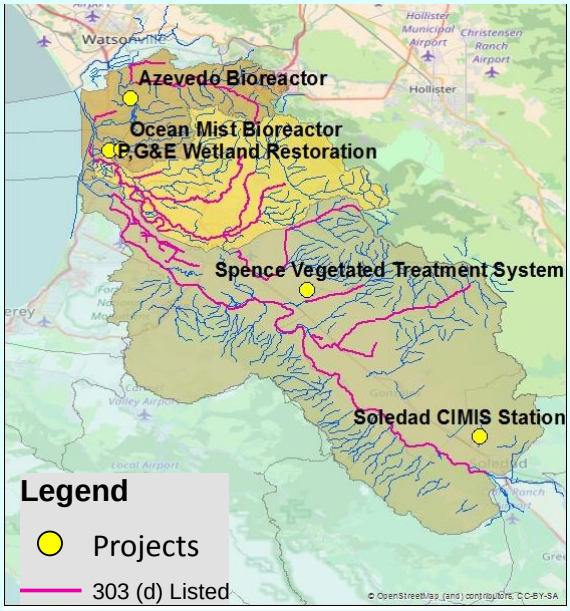
Salinas Valley Irrigation and Nutrient Management Program: 12-414-553

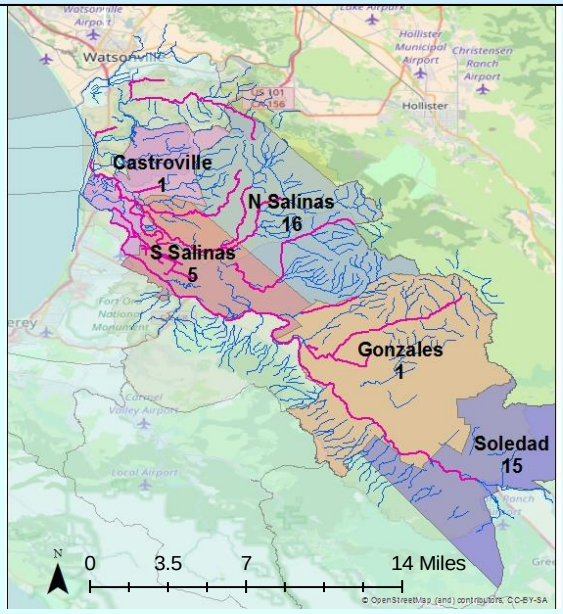
California's Nonpoint Source Pollution Control Program

Salinas, CA

Final Project Summary 2013-2017

Lower Salinas Watershed





Structural Projects: 1 Treatment Wetland, 2 Bioreactors, 1 CIMIS Station, 1 Vegetated Ditch	Irrigation and Nutrient Application Assessments & Projects: 41 fields, 12 growers, 71 assessments, Lower Salinas watershed: 211 tons N/yr less fertilizer N, 2704 acre-ft/yr less water.

Background

The lower Salinas Valley is a 405 square mile area located on the Central Coast of California, composed of three watersheds (Lower Salinas River, Reclamation Canal and the Moro Cojo Slough) that drain into the Monterey Bay National Marine Sanctuary. The area has a Mediterranean climate that makes year round agriculture feasible, with mild temperatures and rainfall averaging approximately 14 to 16 inches per year in the farmed areas of the Valley. The highly productive land draws high lease rates with cropland renting from $350 - $3000 per acre depending on location (UCCE 2015), so growers are quite interested in maximizing crop production. Overall for Monterey County, agriculture is of enormous

economic importance with crop production contributing $4.8 billion in 2015 (MCAC 2016).

Crop production is one of the four main land uses in the Lower Salinas area, representing 34% of the land coverage. Other land uses are grazing land (32%), undeveloped or forest (26%), and urban land (8%) (CCRWQCB 2013; Fig. 1). Both surface and groundwater in the region are contaminated with nitrate and other non-point source pollutants. The addition of nitrogen fertilizer and animal wastes is the largest source of nitrate in groundwater (Harter and Lund 2012). Fertilization rates differ by crop type, with the estimated average application rate of 230 lb N/acre/crop for vegetables and berries on irrigated agricultural land in the Salinas Valley (Fig. 2, Harter and Lund 2016). To reduce groundwater nitrate loading to a sustainable level, Harter and Lund estimated a needed reduction of 70 lb N/acre/crop for vegetables and berries. Surface water is also contaminated by runoff from agriculture. Seventeen surface water bodies (creeks, ditches, rivers or sloughs) in these watersheds have been identified as impaired for nutrient contamination by nitrate and/or unionized ammonia.

Project Description

The efforts funded by this grant focused on reducing nutrient levels found in discharges from farm fields through two primary means: 1) improving the application efficiency of irrigation water and nutrients through education and direct technical assistance on the farm and 2) through nutrient treatment structures designed to remove nitrate and orthophosphate from irrigation runoff prior to discharging to public water bodies. With the high density of agricultural production found in the area and the importance of maintaining high yields to pay for agricultural rents, a combination of management practices and runoff treatment is probably necessary to meet regional water quality objectives. Management practices are designed to help growers apply only the necessary amount of water and nutrients for plant growth. Treatment structures, located on-farm or off-farm, remove excess nutrients remaining in the water to achieve the appropriate concentrations for beneficial uses prior to releasing water to a stream or other water body. Beneficial uses for the Salinas Valley waters include drinking water, groundwater recharge, agricultural supply, aquatic habitat and recreation. The overall goal of this program is to improve water quality and make progress toward restoring beneficial uses in waterbodies through education, assessment of irrigation systems and management practices, and implementation of projects.

Project Goals from the PAEP:

1) Provide growers with technical expertise to improve on-farm irrigation and nutrient management practices.
2) Provide growers technical and financial assistance in implementing on-site projects, infrastructures for water management, and/or sub-watershed nutrient treatment structures that can conserve water and reduce nutrient loads to water bodies or groundwater.
3) Make progress toward the achievement of the Lower Salinas Nutrient TMDL water quality targets for nitrate, unionized ammonia and orthophosphate.
4) Reduce nitrate load contributions to groundwater and surface water.

Project Outcome

All major aspects of the grant project have been completed on schedule, although adaptive management is continuing on some implementation projects. Completed major project aspects are shown in Table S1. The few remaining items to complete will be finalized by the deadlines negotiated in the contract. These

Table S1: Grant project tasks.

No.	Title	Description	Percent Complete
B.2	TAC Meetings	PAEP, Load reduction, monitoring plan & reports, QAPP.	100%
A.2-4	Reports	Monitoring plan, monitoring reports,	100%
B.3.	Outreach and Education	Grower participation strategy, recruitment, outreach, education, long term implementation strategy	100%
B.4	Grower Consultations	Contact growers per the developed strategy, schedule consultations, conduct consultations.	
A.6-7	Permitting	CEQA, Public agency permits and approvals.	100%
B.5-6	INMP Assessments & Recommendations	Conduct irrigation and nutrient management assessments and provide a report with recommendations.	100%
B.7	Implementation Projects	Site selection, project design & construction, project monitoring & evaluation.	100%
Exhibit B.A-G	Invoicing, budgeting and reporting	Quarterly invoicing, quarterly reports, annual reports, final report, final project inspection and certification.	95%

remaining items include NRPI Project Survey Form, and Final Project Inspection and Certification, and the last invoice and quarterly report.

Efforts to improve application efficiency of water and nutrients exceeded the grant requirements. The grant specified that 5 irrigation assessments and 5 nutrient management assessments would be performed. We accomplished a total of 18 irrigation distribution uniformity evaluations, 28 irrigation scheduling assessments, and 25 nutrient management assessments. All assessments were followed up with recommendations to the growers for bringing about improvements, if needed. A CIMIS weather station was built near Soledad as a structural project to help growers in this area manage water and nutrient application to 60,000 acres of irrigated land. This CIMIS station has been completed, however the grass understory does not yet meet the standard for growth. When this is achieved, the Soledad CIMIS station will go online on the CIMIS website and will be used in the CropManage decision support tool.

A total of 4 nutrient treatment structures were installed to remove nitrate and orthophosphate from irrigation runoff prior to discharging to public water bodies. These projects included 1 vegetated ditch treatment system, 2 woodchip bioreactors and 1 treatment wetland. The Spence vegetated treatment system (VTS) was completed and operational in June 2015, the Oceanmist bioreactor in April 2016, the PG&E treatment wetland in November 2016 and the Azevedo bioreactor in January 2017. At the current time, neither bioreactor is operational due to the high amount of precipitation from winter storms. The outlet of the Oceanmist bioreactor into the Seamist wetland is too high to receive more water and the inlet sediment pond at the Azevedo bioreactor has become too inundated with sediment for the floating pump to operate.

Project Performance

Prop 84 projects provide ecosystem and human benefits beyond the removal of non-point source pollutants. These benefits include water conservation, reduced nitrate leaching, habitat restoration, outreach and education, beautiful open space, demonstration sites for consideration by other growers, and locations for further research (Table S2). Specific examples of these benefits include the Spence Vegetated Treatment system (VTS), which was used to demonstrate how carefully calculated nutrient and irrigation water addition can result in almost no runoff during the growing season. The grower at this location managed irrigation so precisely that only two runoff events into the VTS occurred in both the summer of 2015 & 2016 generating an average of less than 5000 gallons of runoff per event, all of which completely infiltrated prior to reaching the outlet in the VTS. He managed fertilizer so precisely that this runoff only contained 3.3 mg/L of nitrate as N. UC Davis Granite Canyon lab also used the Spence VTS for pesticide removal trials and provided grower outreach at the site regarding trial results. The PG&E constructed wetland is another example of high value added beyond nutrient removal. It provides habitat value for fish, reptiles, amphibians, birds and small mammals as well as putting land into open space in perpetuity. This wetland restoration project has supported the implementation of a critical portion of the Moro Cojo management plan.

Table S2: Project benefits to the ecosystem and human endeavors.

Project	Project Benefits
INM Assessment & Implementation	Nutrient removal, water conservation, education
CIMIS Station	Nutrient removal, water conservation
PG&E Treatment Wetland	Nutrient Removal, habitat restoration*, outreach and education, beautiful open space, demonstration site, location for further research
Oceanmist Bioreactor	Nutrient removal, location for further research
Azevedo Bioreactor	Nutrient Removal, outreach and education, demonstration site, location for further research
Spence Vegetated Treatment System	Nutrient Removal, outreach and education, demonstration site, location for further research

*** Habitat restoration at PG&E wetland is valued at $240.000**

Nutrient load reduction was calculate for both application efficiency projects, designed to reduce water and nitrogen use, and for structural projects, designed to remove nutrients from runoff. Table S3 shows the estimated load reduction based on current monitoring data for the bioreactors and wetland and based on grower interviews for the INM Assessments and Implementation. For the Oceanmist bioreactor, we reported the percent load reduction and not the numeric reduction because we have an agreement with the landowner not to share actual numbers.

Table S3: Load reductions for nutrients from the 6 grant projects based on current monitoring data or grower interviews.

			Nitrate: Predicted with maturation		Capital Cost of Nitrate Removal		
#	Project	Project Type	Estimated Percent Load Reduction	Estimated Annual Load Removal (kg/yr)	Estimated Project Life	Asset or Service Cost (not including O&M)	Capital Cost per kg of Nitrate Removed* ($/kg)
1	INM Assessment & Implementation	Application Efficiency	ND	191,400	10	$323,485	$0.17
2	CIMIS Station	Application Efficiency	ND	ND	20	$143,100	ND
3	PG&E Treatment Wetland	Nutrient Removal	84%	5950	20	$600,000	$5.04
4	Oceanmist Bioreactor	Nutrient Removal	59%	NA	20	$93,000	$1.23
5	Azevedo Bioreactor	Nutrient Removal	73%	3.6	20	$32,000	$444.44
6	Spence Vegetated Treatment System	Nutrient Removal	100%	0.5	20	$85,615	$8561.50*

*** The capital cost of nitrate removal at the Spence VTS is higher than other projects due to the substantial decrease in fertilizer and water application the grower achieved through best practices. The VTS is capable of a much higher removal rate than was observed, however due to very low inputs of water and nitrate it was not operated to full capacity.**

As the grant was finalized in March 2017 before many of the projects were able to demonstrate their full potential to remove nitrate, we estimated future removal rates using performance from similar mature treatment structures found in the scientific literature. Table S4 shows predicted nitrate load removal at maturity based median denitrification rates found in our literature review. Table S4 also displays the capital cost associated nitrate removal over the project life. These costs do not include ongoing operation and maintenance costs, all of which will be assumed by the land owner. The total ecosystem and human benefit of projects is also not captured by the capital cost of nitrate removal shown in Table S4.

Table S4: Anticipated nitrate load reduction from the grant projects based on scientific literature median denitrification rates. Capital cost of nitrate removal falls short of representing the total benefit of each project.

			Nitrate: Predicted with maturation		Capital Cost of Nitrate Removal		
#	Project	Project Type	Estimated Percent Load Reduction	Estimated Annual Load Removal (kg/yr)	Estimated Project Life	Asset or Service Cost (not including O&M)	Capital Cost per kg of Nitrate Removed* ($/kg)
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5	Azevedo Bioreactor	Nutrient Removal	73%	3.6	20	$32,000	$444.44
6	Spence Vegetated Treatment System	Nutrient Removal	100%	0.5	20	$85,615	$8,561.50

Project performance was evaluated compared with the goals and targets set forth in the Project Assessment and Evaluation Plan (PAEP). In most cases project performance exceeded the expectations of the PAEP as shown in Table S4 and Table S5.

<u>Application Efficiency Projects</u>

We conducted more INM assessments than targeted, and growers implemented more BMPs from recommendations made than were targeted. The water and nutrient reduction growers accomplished was measured or estimated in terms of a numeric savings and percent reduction specified in the PAEP. Average water reduction was 5 in/acre with individual growers applying between 10-40% less water,

performing above the targeted 5-20%. Average fertilizer N savings was 38 lbsN/acre/year with individual growers applying between 0%-30% less N fertilizer, performing below the targeted reduction of 10-40%.

Table S5: PAEP project goals and targets compared with accomplishments.

Project Goals	Targets	Accomplishments
1) Provide growers with technical expertise to assess on-farm irrigation and nutrient management practices.	1.1. *Conduct a minimum of 5 with a goal of 10 irrigation practice assessments.*	*1.1 Conducted 18 irrigation system distribution uniformity evaluations and 28 irrigation scheduling assessments.*
	1.2. Conduct a minimum of 5 with a goal of 10 nutrient management assessments.	*1.2. Conducted 25 nutrient management assessments.*
	1.3. For each assessment record the following information: crop type, irrigation type, acres impacted and hours consulted.	*1.3. Recorded this information for all assessments and included it in quarterly reports.*
	1.4.50% - 75% percent of growers receiving assessments independently implement at least one BMP included in the assessment recommendation form.	*1.4. Worked with 12 growers and had follow up contact with 10 growers. Of the 10 growers contacted, 100% had implemented at least one BMP, all were self funded.*
2) Provide growers technical and financial assistance in implementing on-site projects, water conservation insfrastructure,and/or sub-watershed nutrient treatment structures that can conserve water and reduce nutrient loads to water bodies or groundwater.	*2.1. On-farm BMP implementation: Achieve a reduction of 5-20% in water use on farms implementing irrigation BMPs, reduce nitrogen addition by 10-40%.*	*2.1. Contacted 5 out of 8 growers who received irrigation scheduling assessments, many on multiple fields. Water reduction varied between 3 - 12 inches for a crop, a 10-40% reduction. Average water reduction was 5 in/acre. Fertilizer N reduction varied between 0 and 73 lbsN/acre/yr, with an reduction average of 38 lbsN/acre/yr. This represents 0-30% reduction in nitrogen addition.*
	2.2. WM Infrastructure - CIMIS Station: A) Compare CIMIS data to closest alternative to evaluate increased accuracy of ET data, and B) Survey growers to evaluate the importance of increased confidence in using data	*2.2. The CIMIS Station went online 2/20/17 and ET data is available to growers farming 60,000 acres of land near Soledad. The short operational timeframe was insufficent for a comparison to other stations or a survey of grower confidence.*

Growers who received assessments were interviewed, and they provided information on estimated or measured water and fertilizer savings compared with previous usage across their entire operation. Growers reported that learnings from assessments were generally applied across their entire operation, not just on the fields evaluated. Based on grower feedback, a total of 2704 ac-ft/yr less water is being used for irrigation and a total of was 211 tons/year less fertilizer N is used in the Lower Salinas watershed.

Table S5: PAEP project goals and targets compared with accomplishments.

Project Goals	Targets	Accomplishments
3) Make progress toward the achievement of the Lower Salinas Nutrient TMDL water quality targets for nitrate and unionized ammonia.	*3.1 CMP, Assess whether the on-farm effort impacted downstream WQ and why or why not.*	*3.1. There was an insufficient time frame to collect data from monitoring to ascertain whether an improvement was made.*
4) Reduce nitrate load contributions to surface water.	*4.1. Achieve 75% of the load and concentration reduction projections by the end of year 1 after installation. Projections are site specific based on wetland size, inlet load, and the median decay rate found in the literature.*	*4.1. For projects with less than one year of data, we based the percent on the available data: CIMIS ND*; Azevedo ND*; Spence 100%; Oceanmist 71%; PG&E 52%*
	4.2. In aggregate show a collective reduction of 5% in applied water and 15% nitrogen fertilizer by growers in the subwatershed.	*4.2. For the Lower Salinas watershed, a total of 2704 ac-ft/yr less water is being used for irrigation. Average water reduction for growers involved per acre was 0.32 acre-ft/year. Total fertilizer N reduction was 211 tons/year. Average N reduction was 38 lbs/acre. We did not compute the percent reduced collectively.*
		ND = no data

<u>Nutrient Removal Projects</u>

The target for nutrient removal projects was to achieve a load reduction of 75% of the projected load reduction by the end of their first year of operation. Wetlands and bioreactors generally improve performance for a time period after their initiation as the plants and microbial populations become established. For this reason we did not expect 100% performance the first year, but targeted 75% performance. Monitoring data was not collected at the Azevedo bioreactor and could not be evaluated. During its first three months of operation, the PG&E treatment wetland achieved a load reduction of 44% based on monitoring data compared with a future predicted load removal of 84% based on the Tanks in Series model and median removal rates found in the scientific literature. Thus the PG&E wetland achieved 52% (44/84) of the load reduction predicted at maturity compared with a PAEP target of 75%. The Oceanmist bioreactor achieved a load reduction of 42% with an estimated future mature

load reduction of 59%. Thus it achieved 71% (42/59) of the load reduction predicted at maturity compared with a target of 75%. Although both projects underperformed according to target, neither was operational for a full year and much of the monitoring was in winter months when performance is worst due to cold temperatures and lower microbial activity. They would have performed better if they had operated for an entire year.

Irrigation and Nutrient Management

Description

The purpose of irrigation and nutrient management (INM) Assessments is to help growers effectively manage their irrigation water and nutrient additions to meet crop needs so that nutrient loads to ground water and surface water are reduced. Effective INM helps the region make progress toward several environmental objectives including reduced groundwater and surface water contamination, reduced groundwater use, agricultural sustainability, and healthier stream and ocean habitats. INM can benefit the grower through reducing the cost of over fertilizing, reducing water and pumping costs and achieving regulatory compliance. Each grower faces a different set of circumstances that play a role in their choice of management practices that will work best for their organization, current irrigation system, crop type and geo-physical setting. For this reason, on-farm assessments are the most effective way to help growers accomplish INM goal.

By involving growers, farm managers and irrigators in the evaluation & assessment, knowledge and skills are transferred. Although the assessment is applied to a single block, the learnings are commonly transferred across the entire grower operation.

PROJECT LOCATION

Three types of INM assessments were offered through grant funding:

Distribution Uniformity (DU) evaluates the uniformity of water distribution across the field and recommends improvements to the irrigation system so all plants will receive the same amount of water.

Irrigation Scheduling relates to the time, rate and duration of the application of irrigation water to meet crop water needs. Our irrigation scheduling evaluations focused on the use of soil moisture sensors and evapotranspiration as the basis for scheduling irrigation and when appropriate, the use of CropManage as a system for tracking and recommending irrigation amounts and timing.

Nutrient Management: Nutrient management plans document available nutrient sources, production practices, and other management practices that influence nutrient availability, crop productivity and environmental stewardship.

Practice Adoption

Assessments of one or more types were conducted on 469 acres of land over 30 different fields related to 7 different crop types involving 12 growers.

DU evaluations
Number Conducted: 18 total (13 drip, 5 sprinkler irrigation systems)
Recommendations: 48 recommendations, 36 implemented (75%)
Irrigation Scheduling & Nutrient Management Assessments
Conducted 28 Irrigation and 25 nutrient management assessments
12 growers involved
Farm water savings: 3-12 in/acre-ft/yr
Farm fertilizer savings: 0-73 lbsN/acre/yr
Estimated Salinas Valley Benefit
Area managed by 12 growers involved: 9323 acres
Estimated water savings to the Lower Salinas Valley: 2704 acre-ft/yr
Estimated fertilizer reduction: 211 tons N/yr

Partnerships

UC Cooperative Extension and RCDMC provided the technical assistance and the decision support software, CropManage. Grower organizations covered the cost of improvements and employee time. The project was funded by SWRCB Prop 84 grant # 12-414-553.

Prop 84 Grant Funding

State Water Resources Control Board's Proposition 84 Agricultural Water Quality grant paid for the technical assistance. Professional services match was provided by NRCS and UCCE.
Assessment Costs $323,500
Grower: Costs: time, upgrades & maintenance. Benefits: water & fertilizer savings, record keeping & tracking, and reduced risk of con-

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Soledad CIMIS Station

Description

CIMIS stations provide meteorological data including wind speed, temperature, solar radiation and other parameters used for calculating reference Evapotranspiration (ET_0). The Soledad CIMIS Station will provide localized ET_0 to help growers' determine crop water needs for farms representing approximately 60,000 acres of irrigated agriculture in Salinas Valley between Gonzalez and Greenfield. ET_0 in combination with crop coefficients can be used to estimate field (soil and plant) water loss and crop water demands, which augments growers' ability to determine irrigation water application amounts and timing.

Significance

As the importance of conserving water and avoiding nitrate leaching below the root zone has escalated, growers are increasingly concerned with precision irrigation practices. Growers can have increased confidence in ET data when a weather station is located in close proximity to their fields and measures the actual conditions where they are farming, especially in windy areas like the Salinas Valley. Multiple benefits for the region and the individual grower can be gained from precise irrigation to match crop needs, which include:

- avoiding the need to over-apply fertilizer due to leaching,
- reducing irrigation runoff,
- reducing contamination of groundwater with nitrate,
- reducing groundwater use and slowing aquifer depletion,
- cost savings,
- avoiding plant stress from under or over watering,
- and aiding with regulatory requirements.

PROJECT LOCATION

The Soledad CIMIS station, located between the Salinas and Arroyo Seco stations, monitors local climate from atop irrigated fescue grass covering 2 acres of land. Data is sent on an hourly basis to the CIMIS website, where ET_0 data can be accessed: www.cimis.water.ca.gov/

Decision Support Tools

CIMIS ET_0 data is incorporated into decision support tools, such as CropManage, for use by growers and irrigators. CropManage quickly estimates water needs for vegetables and berries. Growers can also use CropManage to track water and nutrient applications.

Partnerships

DOLE provided the land for the CIMIS station as well as ongoing maintenance of the grass. University of California Cooperative Extension (UCCE) provided the CropManage model for utilizing reference ET to calculate crop water needs and irrigation timing. The Resource Conservation District of Monterey County (RCDMC) provided the conceptual design and oversaw the management and construction of the project. The engineering and construction contractor was Irrigation Design and Construction (IDC). The California Department of Water Resources installed the weather station and provides data on the CIMIS website. The project was funded by SWRCB Prop 84 grant # 12-414-553.

Prop 84 Grant Funding

State Water Resources Control Board's Proposition 84 Agricultural Water Quality grant paid for the engineering design and construction of the irrigation system, planting of the fescue grass, and the CIMIS weather station. Professional services match was provided by NRCS and UCCE.

Capital Costs $113,000
Land: $30,000

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Spence Vegetated Treatment System

Description

The Spence Vegetated Treatment System (VTS) is an 1800-ft long ditch vegetated with native grass *(festuca rubra)* that intercepts runoff from 86 acres of farm fields, removing nutrients and other pollutants. Sediment ponds at the field edges capture large sand particles and then culverts transport water under the farm roads, emptying into a bed of rocks. Dense grass in the VTS slows the flow of run-off, settling out fine sediment. Plants uptake nutrients and also reduce the volume of run-off by increasing infiltration and evapotranspiration losses. During heavy storm events the vegetation prevents soil erosion. When sufficient run-off drains to the lowest end of the VTS, this water is collected in a sump and reapplied to the sides of the ditch using drip tape, thus maintaining the grass through the dry season and increasing the treatment surface area. During summer irrigation in 2016, all runoff was infiltrated prior to reaching the outlet.

PROJECT LOCATION

The Spence Vegetated Treatment System (VTS) is located at USDA Agricultural Research Station in the Quail Creek watershed south of Salinas. Quail Creek is 303(d) listed for ammonia and nitrate. The impaired beneficial use is drinking water and the goal is a 65% nitrate load reduction.

Load Reduction

Midpoint sampling over a distance of 615 feet (35% of the VTS) showed a concentration reduction in nitrate of 73% and sediment of 69% during summer irrigation on 7/26/16. Othophosphate removal over the course of the project was variable. Because all water was infiltrated, we surmised total removal of pollutants of 100%.

Date	Flow Rate m3/sec	Load Reduction Percent	Nitrate as N g/hr	Othophospha te as P g/hr	Total Susp. Solids g/hr
7/26/2016	0.00136	100%	16.13	0.98	1486.27
8/2/2016	0.00180	100%	nt	2.72	485.99

Culvert Outlet to VTS Ditch

Culvert Inlet from Sediment Basin

Demonstration Site

The VTS is used as a demonstration site for researchers, agricultural professionals and growers interested in nutrient and pesticide removal by vegetated ditches. UC Davis Granite Canyon Lab tested and demonstrated methods for organophosphate and neonicitinoid pesticide removal. UCCE demonstrated nutrient removal and small-seeded grass that does not provide rodent or bird habitat. The use of CropManage for irrigation water and nutrient application has resulted in low to no runoff during the irrigation season with complete infiltration of any field runoff within the VTS (except during storms).

Partnerships

UCCE provided the conceptual design and outreach to user groups. RCD Monterey County provided the technical design, and the USDA Agricultural Research Station provided the location and earth movement for the sediment basins . The project was funded by SWRCB Prop 84 grant #12-414-553.

Prop 84 Grant Funding

State Water Resources Control Board's Proposition 84 Agricultural Water Quality grant paid for culverts, monitoring equipment, sediment basins, plant establishment and irrigation. The ditch had been previously constructed. Matching funds were provided from UCCE as professional services.

Construction Costs $40,600
Land $45,000

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PG&E Constructed Treatment Wetland

Description

The PG&E treatment wetland covers 18 acres of land in the Moro Cojo watershed. It is designed to reduce nutrients and other NPS pollutants, provide wildlife habitat, and help with flood control. Inlet water is pumped from the Castroville Ditch which drains approximately 800 acres of land farmed predominantly in artichokes and brussel sprouts, as well as a portion of the storm-water runoff from Castroville. Water is gravity fed through a 1.25 km sinuous channel that includes depressions and ponds that support wetland plants and sediments that denitrify agricultural water. The treated water then flows into the Castroville Slough about 200m downstream of the inlet, and out to the Moro Cojo Slough before joining Old Salinas River and flowing the into the Pacific.

Water Quality Issues

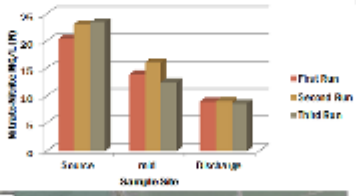
Nutrient concentrations within the Castroville Ditch have been documented between 10-45 mg/L Nitrate as N. The Castroville Ditch flows into the Moro Cojo Slough where the endanged tidewater goby is found along with rainbow trout and other fish species. The Moro Cojo Slough is on the 303(d) list for high ammonia, sediment and low dissolved oxygen.

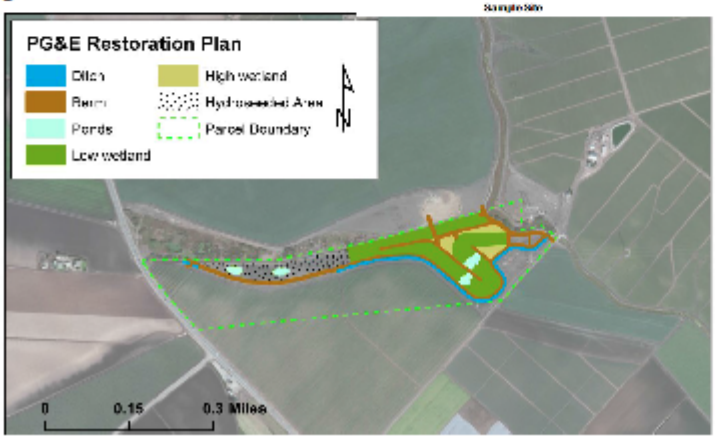
PROJECT LOCATION

Nutrient Removal

Load and concentration removal are estimates based on typical wetland performance and will be validated by monitoring:

Area contributing runoff: 800 acres
Wetland land area: 18 acres
Water volume: 12,000 yard^3
Capacity: 220,000 gal/day
Nitrate-N Load Reduction: 5950 lbs/yr
Nitrate Removal: 84%
Orthophosphate Removal: 86%
Ammonia Removal: 60%





Partnerships

The Central Coast Wetlands Group (CCWG) provided the conceptual design, coordinated with the owners and contractors, obtained permits and oversaw the construction. PG&E provided the land and project support. Waterways Consulting provided the technical design and Durden Construction Inc. completed construction. Coastal Conservation and Research grew the 30,000 native wetland plants that were planted. Monterey County Mosquito Abatement and SeaMist Farms provided earthmoving and on-site support to establish ditches around perimeter. The project was funded by SWRCB Prop 84 grant # 12-414-553.

Prop 84 Grant Funding

State Water Resources Control Board's Proposition 84 Agricultural Water Quality grant paid for biological monitoring, wetland construction, and water quality monitoring. A Department of Water Resources (DWR) Integrated Regional Water Management Plan Implementation grant covered the engineering designs and permitting costs. Matching funds were provided from NRCS and UCCE as professional services. PG&E dedicated land use and paid for west end Frog Ponds. Monterey County supported installation of new pumping infrastructure.

Design & Engineering: $82,000
Permitting & Planning: $45,000
Land: $92,000
Construction & Mgmt: $455,000
Total Cost: $674,000*

* Project costs include frog pond. Costs could be reduced by $162,000 if prevailing wage and permitting were eliminated.

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Oceanmist Bioreactor

Description

The half acre Oceanmist bioreactor treats runoff from approximately 100 acres of farmland growing predominantly artichokes and brussel sprouts. The bioreactor receives and treats runoff from three agriculture drainage ditches that support extensive tile drain systems.

A sinuated channel was created to minimize bypass within the system and simulate plug flow conditions. The channel was excavated and lined with pond liner to create a containment basin, and then filled with woodchips from the local landfill. Woodchips provide a carbon source for denitrifying microbes, thus increasing the nitrogen removal rate.

The pumping rate into the bioreactor varies depending on water level in the drainage ditch collection point, which varies with field runoff and stormwater. The higher the flow rate into the bioreactor, the more nitrate load is removed; however concentration reduction is less at higher flow. The bioreactor discharges to the Seamist wetland restoration site, serving as a pre-treatment system to remove contaminants and clean up water prior to entry into the wetland habitat.

PROJECT LOCATION

Water is pumped into the bioreactor from a collection point of three agricultural drainage ditches. This water then flows passively through the bioreactor to the outlet where it gravity feeds into the Seamist wetland. From there water flows into the Moro Cojo Slough, before joining the Old Salinas River. The Old Salinas River flows out to the Pacific Ocean at Moss Landing Harbor, where it also meets and mixes with water entering Elkhorn Slough during incoming tides.

The Moro Cojo Slough is home to the endangered tidewater goby and is 303(d) listed for ammonia, sediment, and low dissolved oxygen. Old Salinas River water contributes to the hypoxic conditions found in Elkhorn Slough.

FOR MORE INFORMATION

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Nutrient Treatment

Load and concentration removal are estimates based on 2 months of monitoring. Estimates will be updated through time as the bioreactor microbial population matures and removal rates increase.

Area contributing runoff: 100 acres
Bioreactor land Area: 0.5 acres
Wetted treatment Area: 7500 ft^2
Water Volume: 76,000 gallons
Capacity: 30,000-144,000 gal/day
HRT: 0.5—1.5 days
Nitrate Removal: 42%
Nitrate-N Load Reduction: 42%
Orthophosphate Removal: 29%
Orthophosphate Load Reduction: 29%

Ammonia Removal: Ammonia increased in the bioreactor, although outlet concentrations are well below EPA criteria limits. Steps are being taken to correct this issue.

The Department of Pesticide Regulations is planning field trials in 2017 to test pesticide reduction.

Partnerships

CCWG provided the conceptual design, coordination with the owners and contractors, obtained permits and oversaw the construction. The RCD of Monterey County provided the technical design. Oceanmist Farm provided the land, the inlet pump, and helped with the excavation of the basin. The project was funded by SWRCB grant # 12-414-553.

Prop 84 Grant Funding

State Water Resources Control Board's Proposition 84 Agricultural Water Quality grant paid for excavation, woodchips, pond liner, piping, project coordination and engineering. Oceanmist Farm provided the land and inlet pump. Monterey County Mosquito Abatement provided earth moving.

Construction: $88,000
Land: $5000
TOTAL: $93,000

Azevedo Bioreactor

Description

The Azevedo bioreactor treats runoff from 10 acres of strawberry fields on the Azevedo Ranch adjacent to Elkhorn Slough. Irrigation and storm water runoff from the strawberry fields travels down farm roads and into a sediment basin where heavier sand particles settle out. Water is actively pumped into the bioreactor inlet from a floating pump powered by a solar panel and battery pack. The pump turns off when the water level falls below a threshold depth. The bioreactor is a pond-lined basin filled with woodchips purchased at the local waste disposal facility, with care to insure a low percentage of eucalyptus. Water levels are controlled by a level control box at the outlet of the bioreactor. Cleaned outlet water is gravity fed into a ditch that carries it to a tidally influenced pond on Elkhorn Slough Foundation property. From the pond it is conveyed by a culvert under railroad tracks and into Elkhorn Slough.

PROJECT CONSTRUCTION

The bioreactor treats agricultural runoff through the action of denitrifying microbes that convert nitrate to nitrogen gas. Microbes live on the woodchip and pond liner surfaces and their growth is stimulated by the carbon contained in the woodchips. The woodchips are anticipated to last for 10-15 years, before requiring replacement.

The bioreactor is designed to treat up to 4300 gallons per day with a hydraulic retention time of 25 hours. The dimensions are 50 ft (L) by 8 ft (W) by 4 ft (D).

PROJECT LOCATION

Nutrient Treatment

Inlet nitrate as N concentration measures varied between 1 to 11 mg/L. Nitrate removal in the new bioreactor has not yet been assessed, but is expected to be 90%.

Demonstration Site

The Azevedo bioreactor is a demonstration site for researchers, agricultural professionals and growers interested in nutrient and pesticide removal by bioreactors.

Partnerships & Funding

The Ag Land Trust of Monterey County owns the Azevedo Ranch. They provided the land and paid for materials and construction. The RCD of Monterey County provided the technical design. Stockman's Energy designed the inlet pumping system. The technical design of the project was funded by SWRCB Proposition 84 grant # 12-414-553. Matching funds were provided from NRCS and UCCE.

Project Cost: $32,000

FOR MORE INFORMATION

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